Notes on *Nudaurelia cytherea capensis* Stoll., and *Nudaurelia cytherea cytherea* Fabr. (Saturniidae)

By J. S. Taylor

For seevral years, since 1957, prior to his retirement in 1963, the writer gave some time to a biological study of *Nudaurelia cytherea capensis* Stoll., otherwise known as the Pine Tree Emperor Moth, in the Eastern Cape Province, and more particularly in the neighbourhood of Port Elizabeth where he was then stationed.

The larva is well known throughout the timber-growing areas of the Cape as a defoliator of *Pinus radiata* D. Don., having been recorded as such since 1885. In the Transvaal and Swaziland, also possibly in parts of Natal, its place appears to be taken by *Nudaurelia cytherea cytherea* Fabr. The taxonomic position of the two insects remains uncertain, but it is thought that they both deserve specific rank. However, until such time as a thorough examination of their genitalia can be undertaken they must be considered as two separate subspecies of the same insect.

The greater part of the present paper concerns *capensis* but some data regarding *cytherea* are given towards the end.

Tooke and Hubbard (1941) gave a full account of the life-history and control measures for *capensis*, as known at that time. They also refer to *cytherea* as occurring in the Transvaal. Its host-plants were then unknown, and it is stated that it "had never been known to attack exotic trees".

Nudaurelia cytherea capensis

Host-plants and host preferences

To the list of larval host-plants given by Tooke and Hubbard (*op. cit.*) can now be added the following:—

Leucospermum ellipticum Thb.
Protea mundii Klotz.
Rhus crenata Thb.

Acacia saligna Wendl.

By far the most popular host in the vicinity of Port Elizabeth is *Leucospermum ellipticum* which is found commonly in the western part of the district. At the appropriate times eggs and larvae of *capensis* can almost invariably be found on this plant. Other species of *Proteaceae* are also sometimes affected, while species of *Watsonia* and the leaves of guava are much favoured.

Where *Leucospermum* occurs it is often heavily infested, the plants being frequently defoliated, while plantations of *P. radiata* in the near vicinity may be left untouched. While this often happens in the Port Elizabeth area it is not always the case. However, for pine plantations in this area to be severely infested by *Nudaurelia* would appear to be unusual, if not the exception. The situation is quite different in the George-Knysna area, however, where pine plantations suffer severely from attack by the larva of the Emperor Moth. Here Proteaceae appear to be less prevalent. This also applies to the Grahamstown area where *P. radiata* on the local golf course has been heavily infested in recent years. A search of indigenous Proteaceae in the surrounding hills revealed no trace of *Nudaurelia*, while similar results were obtained in a large nursery where numerous species of Proteaceae are extensively cultivated.

At the Grahamstown golf-course many trees of *P. radiata* were completely defoliated and appeared to be dead or dying, their state being due at least in part to attack by *Nudaurelia*. In August 1961 this was particularly noticeable. Most of the *P. radiata* trees were stripped bare while *Pinus halepensis* Mill. trees were left untouched. Thousands of starving larvae were wandering around, many crawling on grasses and low-growing plants, while some were feeding on wattle (*Acacia molissima* Willd.) and on Eucalyptus.

Great difficulty was experienced in rearing larvae from the egg to maturity, particularly on *P. radiata*, even with larvae sleeved on growing pine; only four of the latter ever reached maturity. More success was achieved with *Leucospermum* and with guava, both of which were preferred to pine, more especially if the parent generation had not been reared on pine. Sometimes, however, larvae from pine-reared parents refused anything but a diet of pine, although usually *Leucospermum* and guava were readily accepted by larvae from any source, while it was easier to rear larvae to maturity on either of these host-plants than on pine, even if the latter were growing.

In connection with these host preferences, it is interesting to record that larvae, from eggs sent to Mons. P. C. Rougeot, of Muséum National d'Histoire Naturelle, Paris, thrived on *Quercus* and *Craetaegus*, but that those supplied with *Pinus sylvestris* L., all died.

Seasonal history

Tooke and Hubbard (*op cit.*) refer to two biological strains of *capensis*, the more common being that found in both eastern and western sections of the Cape. In this strain, the peak of emergence takes place in May and larvae occur until late November. In the other strain, which is stated to be not nearly so common, and is found in Natal, the adult emerges from January to April, while the larva occurs until July. In the present writer's experience, the first strain, in which adult emergence is at its peak during May, is found throughout the coastal area of the Cape from Alexandria to Cape Town, while the second strain is found inland as at Grahamstown, where emergence took place from mid-February to mid-April, and which, incidentally, more or less coincided with the emergence period of *cytherea* in the Transvaal.

The adult moth

Tooke and Hubbard (*op. cit.*) also refer to the tremendous range of colour variation in the moth of *capensis*, a fact which was confirmed over and over again by the writer at Port Elizabeth. Here adults from larvae fed on *Leucospermum* varied from light yellow, approximating the Transvaal form *cytherea*, to dark brown. Yellow, however, was the predominating colour. Adults, from pine-fed larvae in the Western Cape were predominantly dark brown in colour. This led to the suggestion that the larval host-plants affected the colouration of the adult, a view supported by the experiments of Pictet (1902) in which he obtained variations in colour and markings in several species of moths by rearing the larvae on different host-plants. However, investigation in Port Elizabeth did not support the theory in this case, and although light yellow adults from *Leucospermum* there predominate, and dark brown specimens from pine in the Western Cape, there would appear to be no hard and fast rule, and both dark and light coloured adults may be derived from either source.

In the George-Knysna area, where *P. radiata* is the principal host, yellowish adults predominate, while the majority of adults at Grahamstown, all derived from pine, were light yellow. Results with moths from Alexandria, reared on *Rhus crenata*, and from Humansdorp on guava, were very much the same, and yellow, or at least yellowish, specimens were in the majority, although there were gradations to darker forms.

Adults were roughly graded into three colour variations, namely light (i.e., yellow), medium and dark. The results from four different localities and hosts are given in tabular form as follows:

Locality and Host	*Light*	*Medium*	*Dark*	*Total*
Port Elizabeth				
Leucospermum	23	1	11	35
Humansdorp				
Guava	18	4	9	31
Alexandria				
Rhus	13	2	7	22
Cape Town				
P. radiata	2	8	27	37

It has been suggested that the variations in adult colouration may have some connection with rainfall and/or humidity during the pupal stage. This might well be the case, the dark form being more typical of the winter rainfall area (Western Cape). On the other hand, if not due to some environmental factor, it may be mutational.

Adults were paired and kept in separate cages at Port Elizabeth. Females lived up to 19 days, while the average duration of life for 15 females was 8·8 days. Males lived for from 5 to 12 days. The moths are reluctant to fly in daylight, but are capable of doing so, especially the males, when disturbed. Males come to light at times, but are not strongly attracted by it. Virgin females bring males; "assembling" being well known in the Saturniidae.

Oviposition was found to commence usually on the second night after the pair had been mated or placed together, but sometimes on the first night. Eggs are generally deposited in small single-layered batches on broad-leaved plants—the largest number found in one batch was 49. On pine needles the eggs are deposited in irregular masses, and are roughly piled one on top of the other.

Up to 220 eggs per female were obtained, the average for 15 females being 140·1.

The incubation period varied tremendously, from 29 days during February-March to 76 days in April-July.

The larva

The larva is to be found in the coastal area of the Eastern Cape on *Leucospermum* from late May onwards, and final instar examples have been recorded as late as the end of October. However, full-grown larvae have been observed on pine near Port Elizabeth in November, and newly-hatched individuals at Grahamstown from the last week of March. Men-

tion has already been made of the difficulty experienced in rearing larvae from the egg to maturity, especially on pine. All seemed to go well until the second moult, after which they commenced to die off in large numbers, with few surviving the third moult. The duration of the larval period varied, under insectary conditions, from 90 days (March-June) to 115 days (May-September).

The pupa

Pupation takes place in dry soil at or near the base of the host-plant or tree, at a depth of from one to two inches. As many as sixty pupae have been found within one foot of the base of an infested pine tree. No cocoon is formed, the larva pupating within its final skin which then splits longitudinally in the dorsal region. It remains in this stage for some 182 to 223 days (September-June), the earliest emergences taking place from the third week of March. Emergence is at its peak during May. In three individual cases emergence was delayed until the second year after pupation. Of 37 larvae which entered the soil for pupation from 28.9.1959 to 22.10.1959, 24 adults emerged from 25.3.1960 to 19.4.1960; 10 dead and 3 living pupae were found in the soil on 28.5.1960 (4 tachinid flies had emerged in November-December). The three remaining living pupae produced adults on 14.4.1961, 28.4.1961 and 17.5.1961, thus resulting in minimum pupal periods of 540, 554 and 573 days respectively. Although it is unlikely that pupae could survive so long under normal conditions, it does at least seem to indicate a potential survival power under extremely dry conditions. All the pupal periods referred to above were obtained under conditions of extreme dryness, the soil in which the pupae concerned were maintained in the insectary never being subject to moisture except for that in the atmosphere.

Natural enemies and controlling factors

Larval parasites of *capensis* recorded in the Eastern Cape are *Apantales maculitarsis* Cam. (Braconidae) and *Sericophoromyia amplipilosa* Curr. (Tachinidae). The cocoons of *Apantales* appear on larvae from the fourth instar, and as many as 26 have been counted on one host. The host may linger on for a few weeks after the parasitic cocoons appear but eventually dies. The tachinid emerges from the prepupa after the host has entered the soil. It is a well-known species, and has been recorded from several other lepidopterous hosts as well. Neither of these two species of parasite is sufficiently numerous to be effective in controlling *capensis*. More important and useful is *Mesocorys pulchriceps* Cam. (Chalcidae) which is often obtained from the egg, and which emerges over a period of ten months. Despite this, however, it cannot be said to exercise effective control. More recently, what may prove to be an efficient predator has appeared. This is the Cape Raven (*Corvultur albicollis* (Lath.). It occurs commonly throughout the George-Knysna area, and may be seen almost anywhere along the main road from Port Elizabeth to Cape Town where it has been quick to avail itself of the carcases of birds and small animals on the roads, the victims of modern traffic. These seldom remain lying long, thanks to the ravens. It has now been reported that they congregate in and near the pine plantations to feed upon the emerging moths. While such reports require confirmation, there seems to be little reason to doubt them.

Domestic pigs have for long been utilised for the control of *capensis* in pine planations where they feed upon the pupae and apparently are most effective (Tooke & Hubbard, *op. cit.*). Many growers still employ them while others prefer the areial application of insecticides.

Sometimes disease controls *capensis;* and this has been the case very recently (1966). The insect at the moment is said to be difficult to find in the George-Knysna area on account of disease.

Nudaurelia cytherea cytherea

From pupae derived from pine-reared material in the Eastern Transvaal in August 1957, adults emerged in Port Elizabeth from 22nd January 1958 until early in the following month. Eggs obtained from a pair retained for breeding purposes hatched in 22 days (February). Larvae were supplied with *Pinus radiata*, *Leucospermum ellipticum* and the leaves of guava. Those supplied with pine at first wandered about but later settled down to feed. However, they did not thrive and shortly afterwards died. The others, given *Leucospermum* and guava, fed readily from the start and growth was rapid. They commenced entering the soil for pupation early in April. The duration of the larval period for those fed on guava leaves varied from 47 to 49 days, with an average of 47·6 days for 11 larvae, while in the case of the *Leucospermum*-fed larvae, the period varied from 48 to 54 days, the average for 15 larvae being 50·3 days (17th February-12th April). The pupal periods for the two varied from 255 to 312 days in the case of *Leucospermum*-fed larvae and from 318 to 328 for the guava-fed individuals. One emergence from *Leucospermum*-fed material took place as early as December 17, but this was quite exceptional, and there were no further emergences until February 3. All the *Leucospermum* pupae had emerged by February 28, while the guava material emerged from February 13 to March 2. All the adults obtained were very light yellow in general colour, there being no variation whatsoever in this respect. Many adults of *capensis* are as light in colour, and an examination of the genitalia should determine whether a specific difference exists. It was possible to attempt the crossing of one pair only, a male *capensis* with a female *cytherea*, and although unsuccessful in that the few eggs obtained were infertile, nothing can be deduced therefrom. It was noticed, however, that the egg of *cytherea* is slightly smaller and more round in shape than that of *capensis*.

It was interesting to note that the period of activity of pine-feeding Grahamstown *capensis* coincided with that of *cytherea*, while the adults in colouring are often almost indistinguishable from those of the latter. Here, however, the resemblance ended, the egg of the Grahamstown moth being typical *capensis*.

Nudaurelia cytherea cytherea is now a well-known defoliator of *P. radiata* in the Transvaal and Swaziland, while a number of indigenous hosts has been recorded. A list of these has been supplied by Dr. J. H. Grobler (*pers. comm.*) as follows:—*Euclea* sp., *Myrica conifera* Burm., *Myrica* sp., *Rhus lucida* L., *Rhamnus prinoides* L'Hérit., *Myrsine* (*Rapanea*) *melanophloeos* R. Br.

Summary

An account is given of the biology of *Nudaurelia cytherea capensis* Stoll., in the Eastern Cape Province. Two biological strains apparently

occur, one coastal and the other inland. The extreme colour variation in the adult is not nutritive and is thought to be due to temperature and/or humidity conditions during the pupal period. *Capensis* is compared with the Transvaal form *Nudaurelia cytherea cytherea* Fabr., and it is thought that they belong to two distinct species, but further investigation is required in this respect.

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June in the South of France

By J. A. C. GREENWOOD, O.B.E., F.R.E.S., and DOROTHY GREENWOOD

We selected our area of operations with quite a lot of care. We wanted a comfortable, modern hotel on a good, sandy bathing beach, not too close to a large town and with as great an area of unspoilt country as possible. Le Rayol fitted this specification admirably. It is about 15 miles west of St. Tropez and roughly half that distance east of Le Lavandou. The hotel, Le Bailli du Suffren, was first-class. There is a superb beach outside the hotel and a small village on the main road a quarter of a mile away.

Between the hotel and the main road the disused railway line, which runs along the coast for many miles, could be entered, and proved a very fertile collecting area.

There was excellent open and wooded country on the way to St. Tropez. By turning inland at Le Lavandou a short but steep road leads to the hill-top village of Bormes and a few miles further on lies the magnificent Forêt de Dom stretching for many miles on either side of an excellent road. Another steep road, largely consisting of hairpin bends, leads up and through the hills to the town of Collobrières, famous for its marrons glacés and crystallised fruits.

Our collecting was concentrated in three main areas:—

(a) The disused railway.

(b) An area on either side of the main road, some 12 miles east of Le Rayol.

(c) The Forêt de Dom.